

# Dust, Smoke, and Sea Salt Concentrations Simulated during CRYSTAL-FACE with MATCH/CARMA

Peter Colarco, GEST/UMBC, NASA GSFC

Brian Toon, LASP/PAOS, University of Colorado

Data from:

Paul De Mott, Mike Poellot, Si-Chee Tsay, Judd Welton, James Campbell, Joe Prospero, MODIS and TOMS science teams

# Motivation

- Simulate dust, sea salt, and smoke aerosol concentrations during CRYSTAL-FACE
- Lend context to aerosol observations made during the experiment
- Assist in interpretation of radiation measurements

# MATCH/CARMA

- 3D aerosol transport model
- Driven by NCEP reanalyses ( $\sim 2^\circ \times 2^\circ$ , 28 vertical layers)
- Physics are from NCAR MATCH model
- Fields are subsetting to a region of interest and fed into CARMA
- CARMA does sources, transport, and removal
- Resolve 8 size bins from 0.1 – 10  $\mu\text{m}$  radius

## Sources

Dust: Ginoux et al. [2001]

Sea Salt: Monahan et al. [1986]

Smoke: *not yet!*

## Removal

Sedimentation

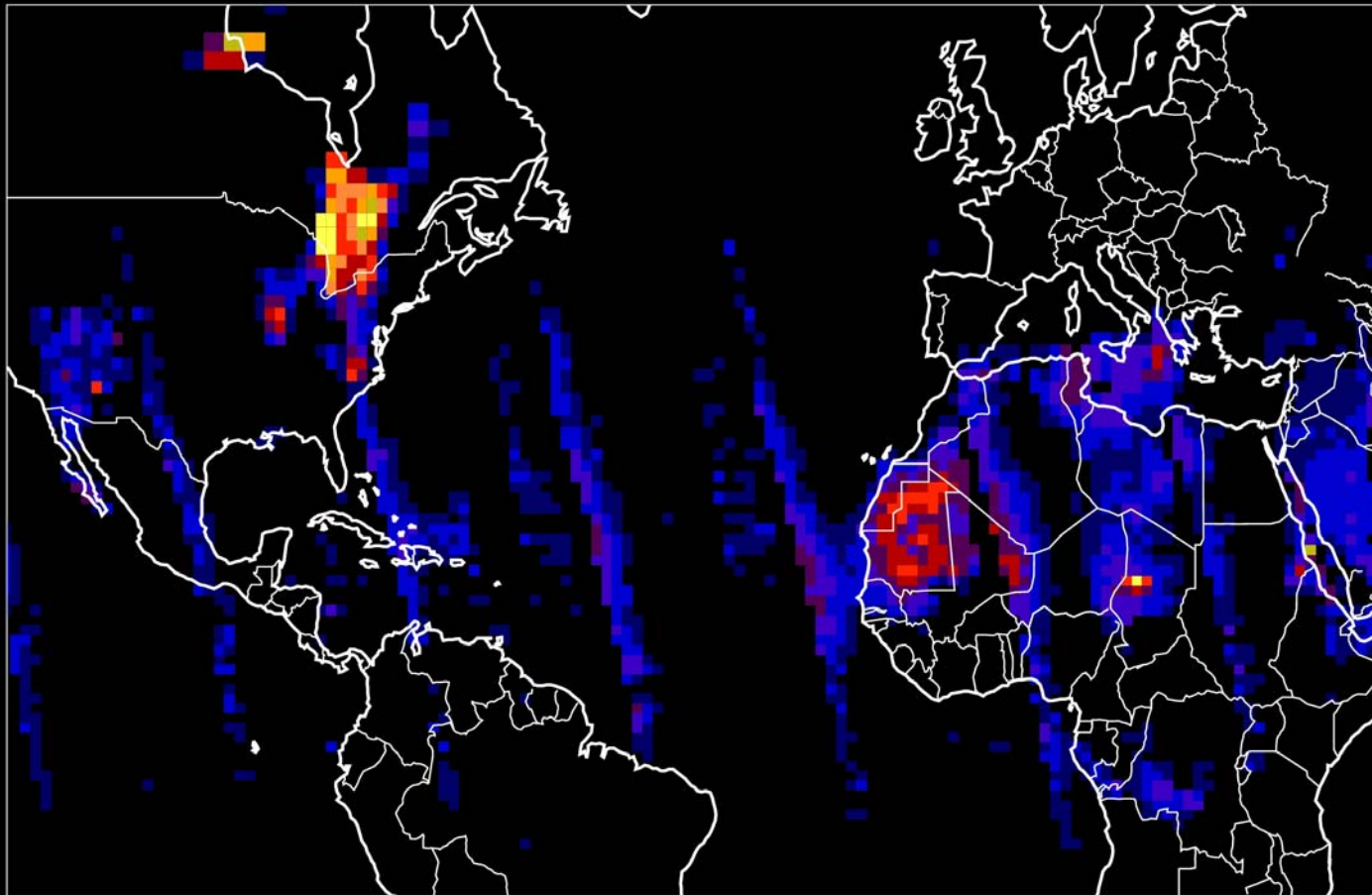
Dry Deposition

Wet Removal

# Smoke: June 29, 2002

EP-TOMS AI

June 29, 2002



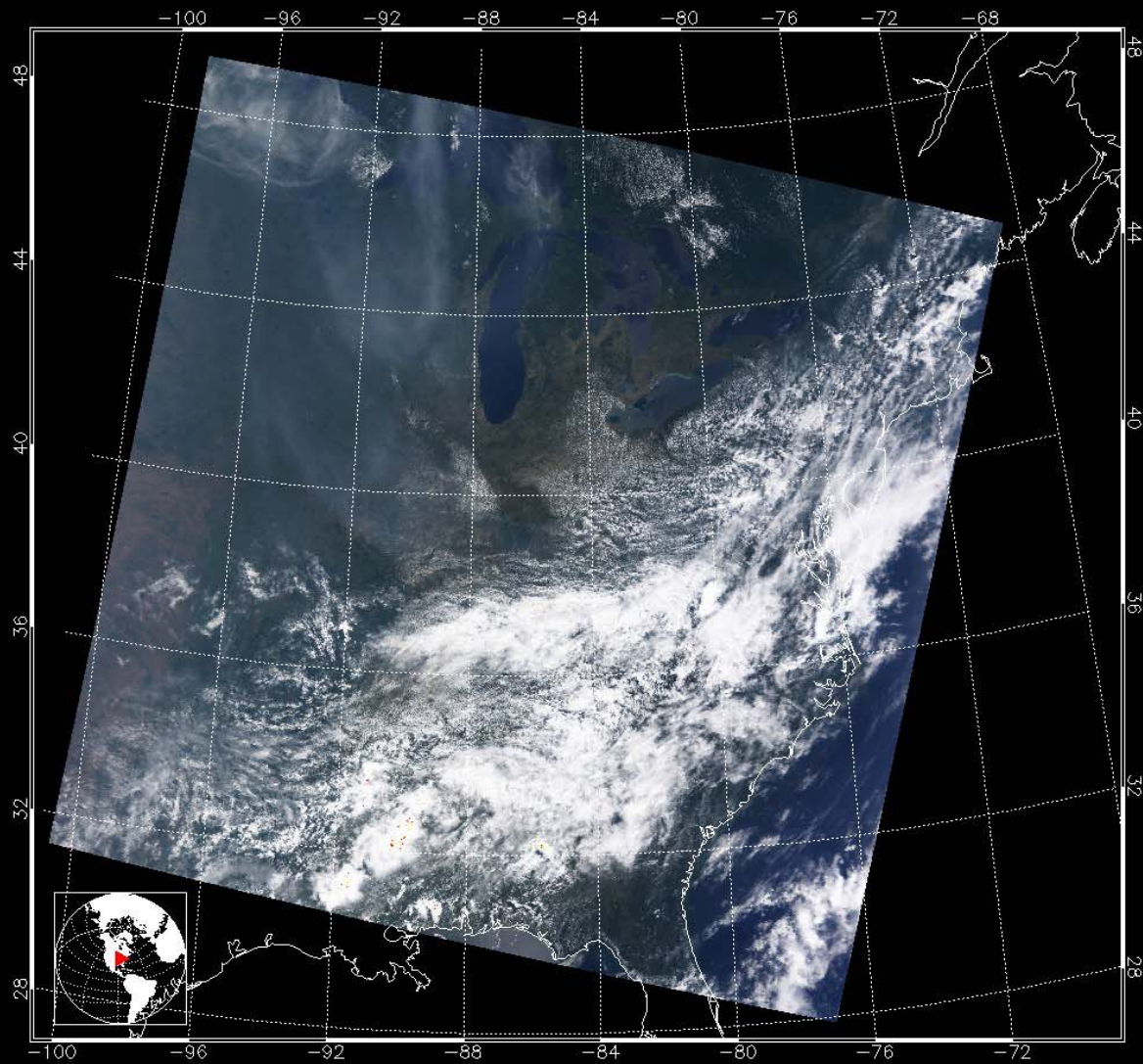
Aerosol Index



0.4 0.8 1.2 1.6 2.0 2.4 2.8 3.2 3.6 4.0

# MODIS-TERRA

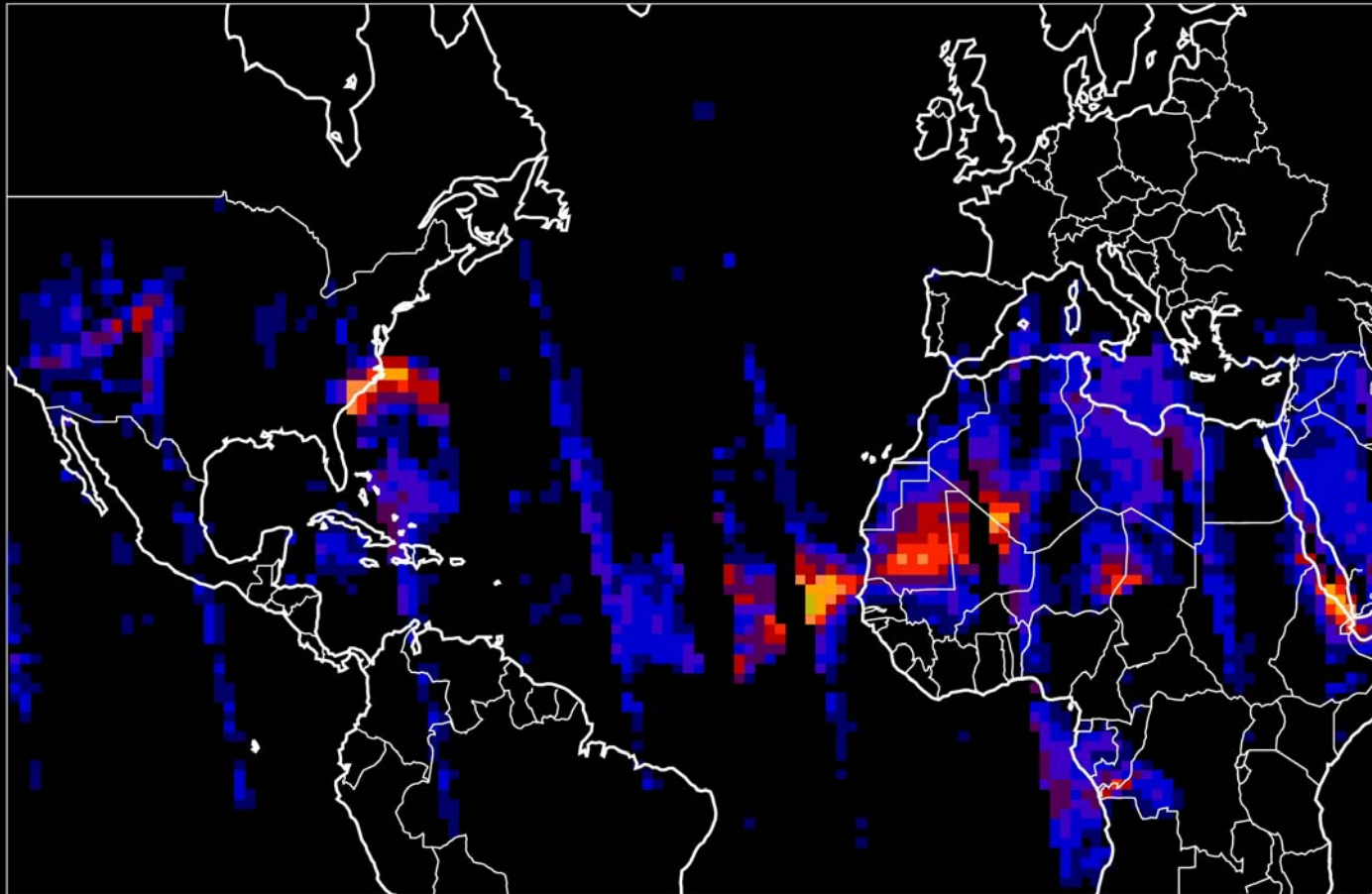
MOD021KM.A2002179.1640.003.2002180034728.hdf



# TOMS: July 1, 2002

EP-TOMS AI

July 1, 2002



Aerosol Index



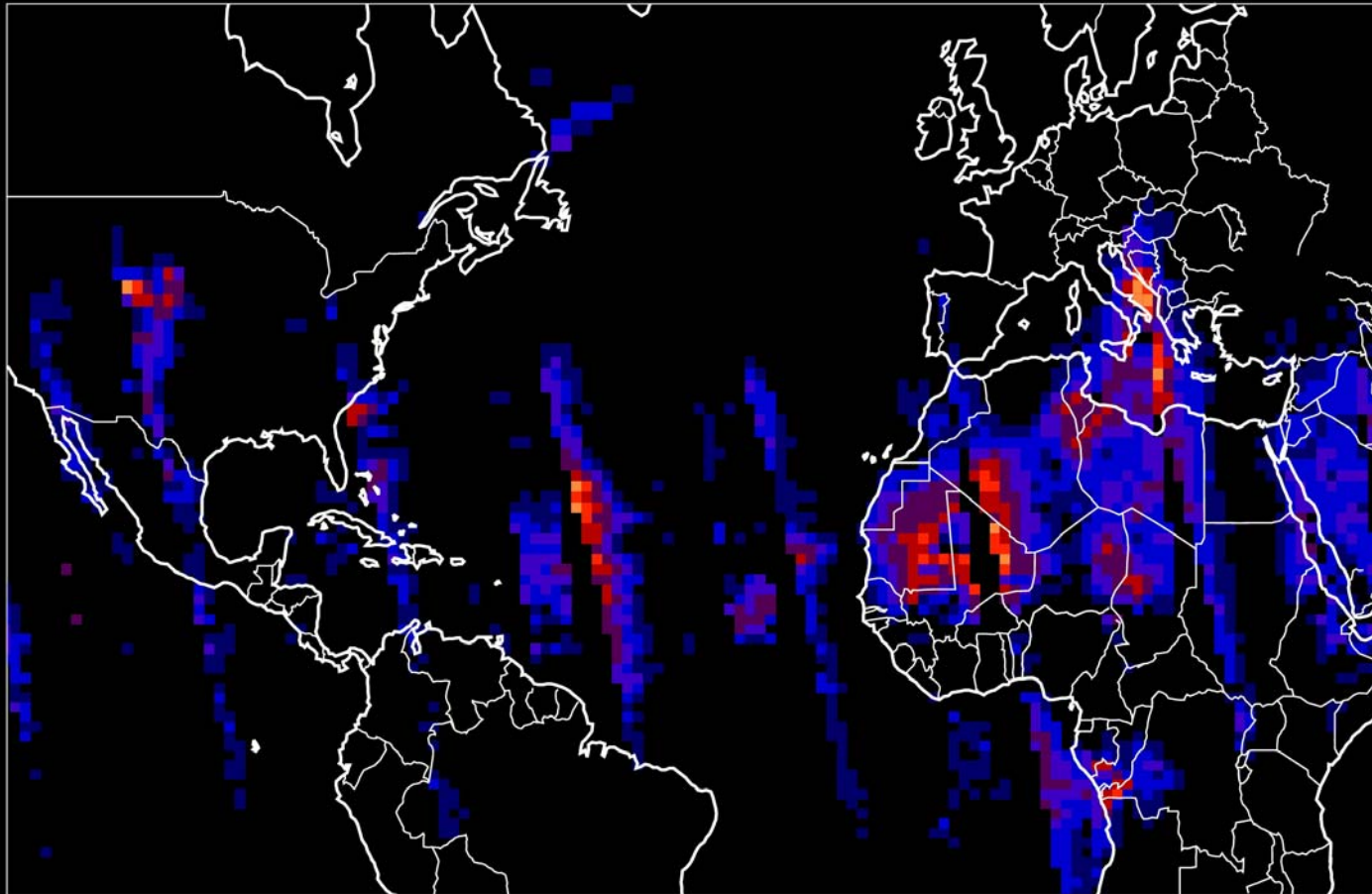
0.4 0.8 1.2 1.6 2.0 2.4 2.8 3.2 3.6 4.0



# TOMS: July 3, 2002

EP-TOMS AI

July 3, 2002

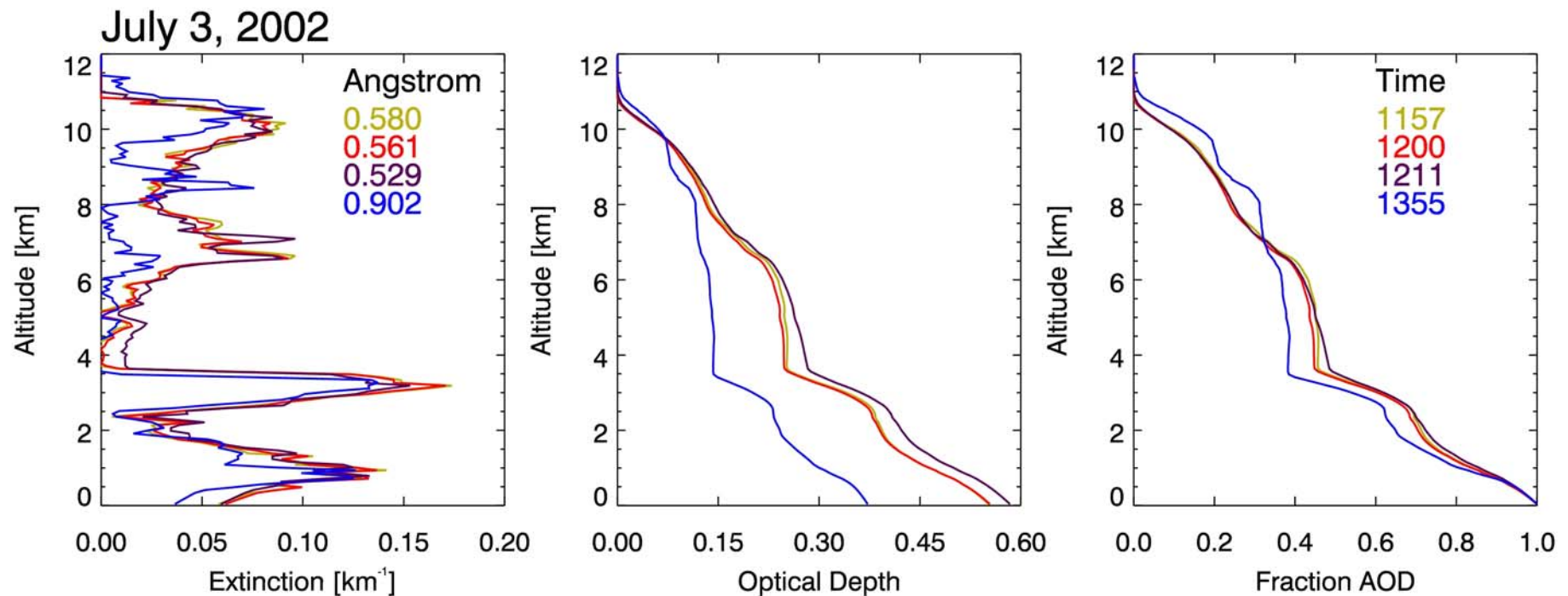


Aerosol Index



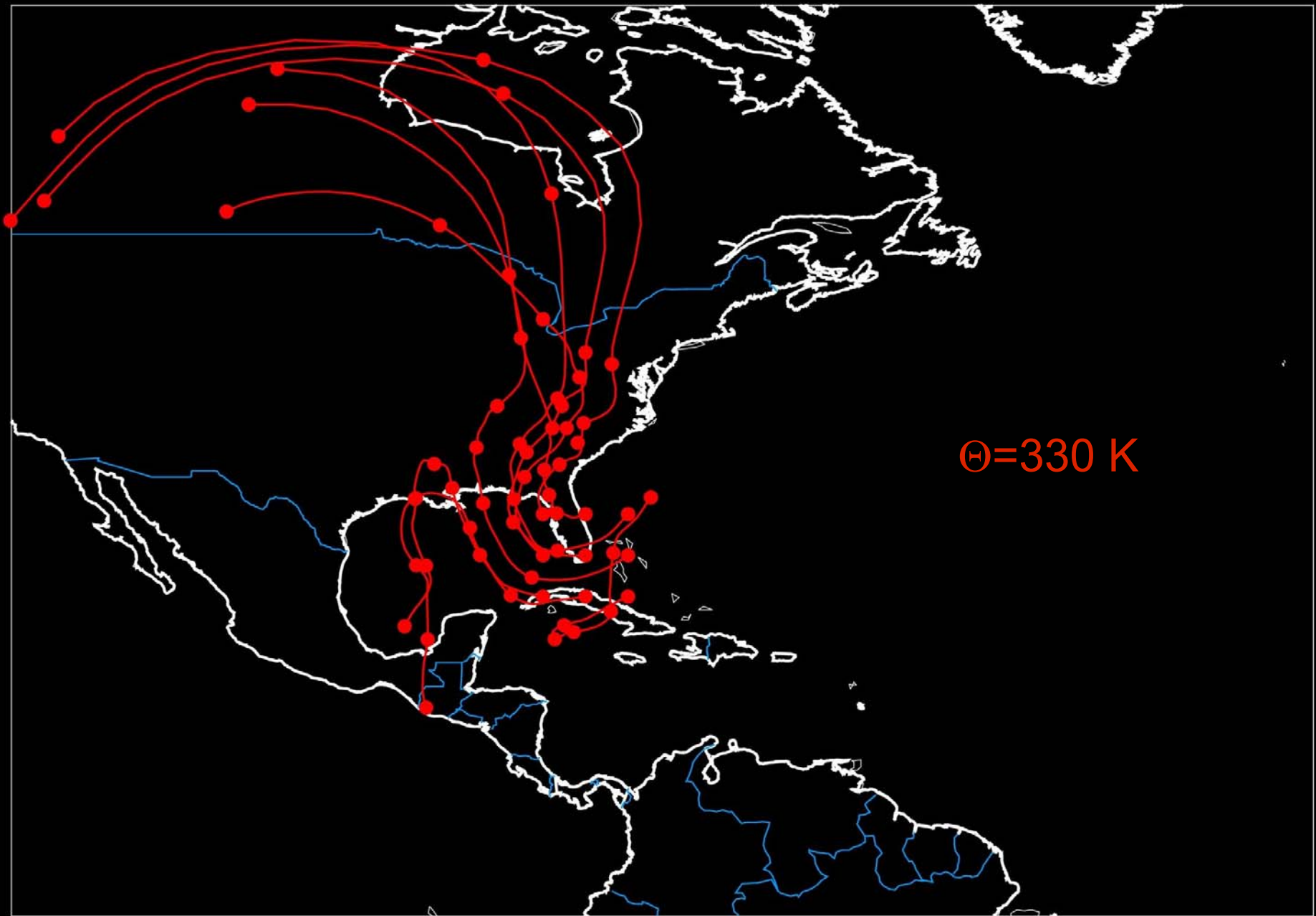
0.4 0.8 1.2 1.6 2.0 2.4 2.8 3.2 3.6 4.0

# MPL at eastern ground site



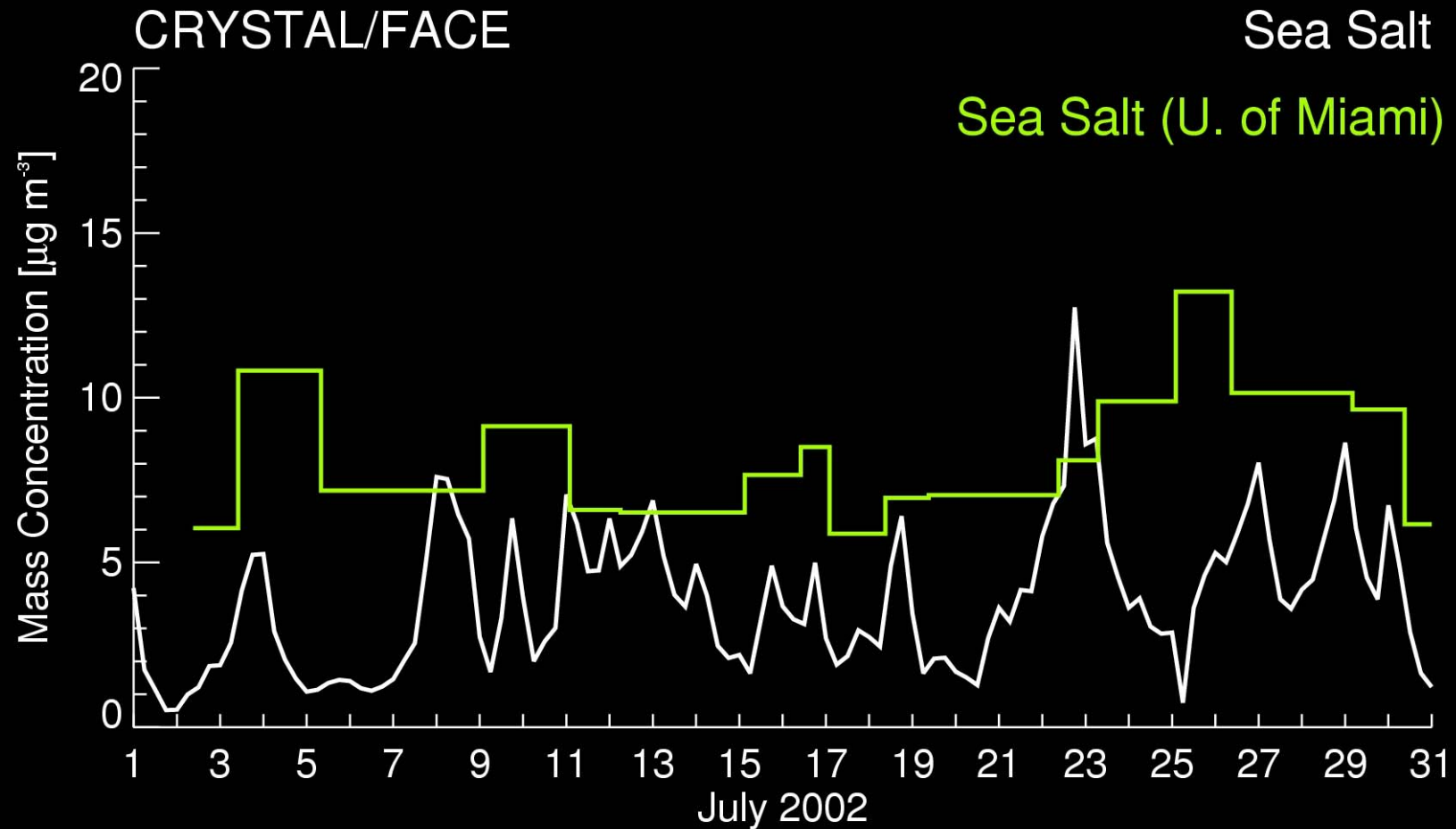


# Back trajectories: July 3, 2002



# Sea Salt

■ Sea salt fluxes are wind speed dependent



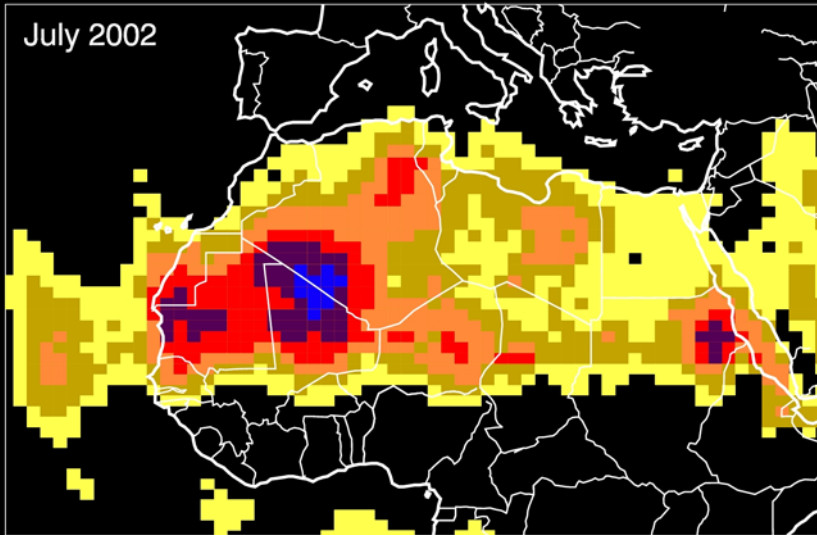
Model Sea Salt Surface Mass Concentration [ $\mu\text{g m}^{-3}$ ]

# Dust Sources

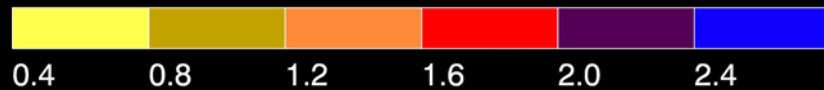
- Dust sources are located preferentially in topographic lows
- Sources are wind speed, soil moisture dependent

EP-TOMS Monthly Average AI

July 2002

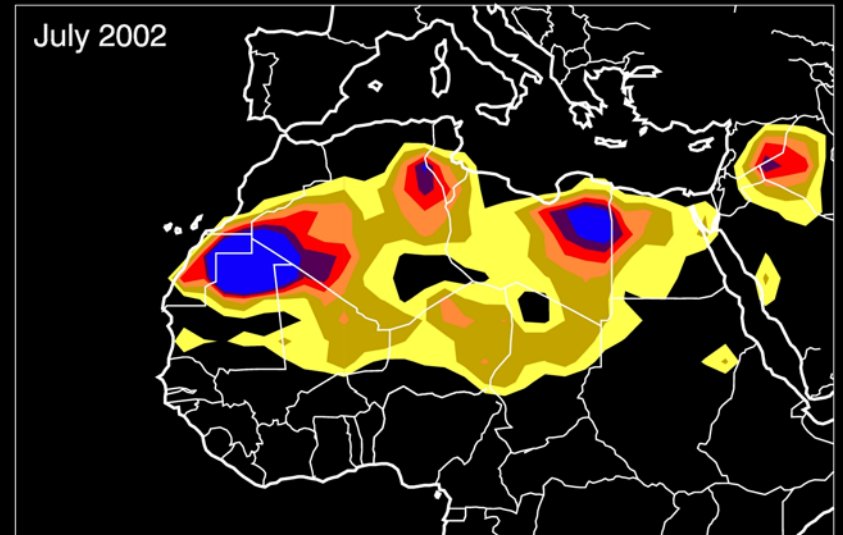


Aerosol Index

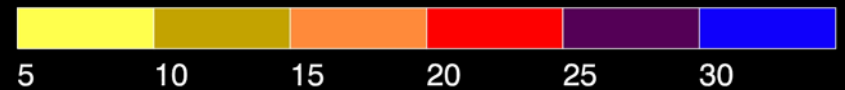


CARMA Dust Emissions

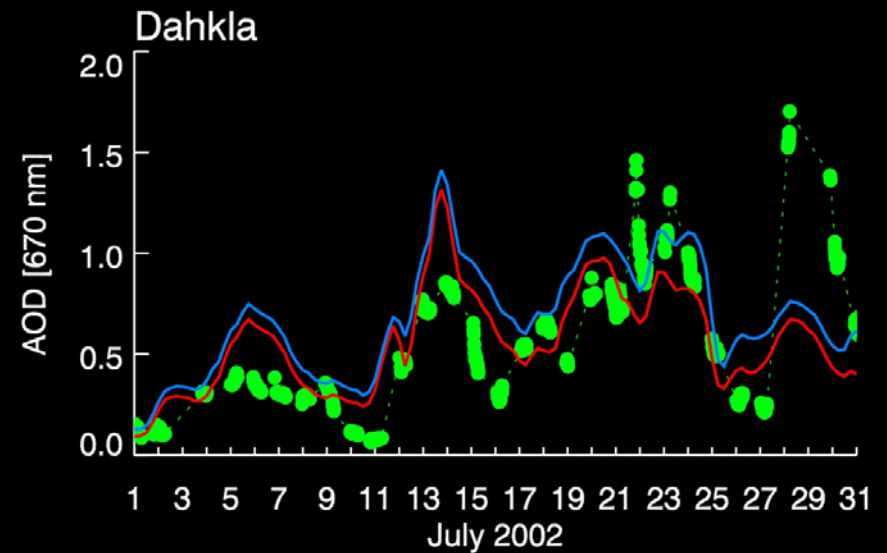
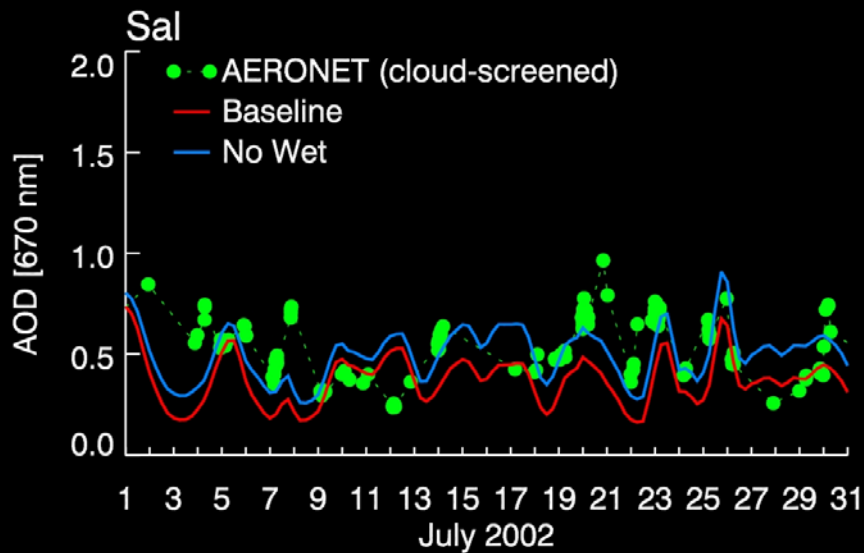
July 2002



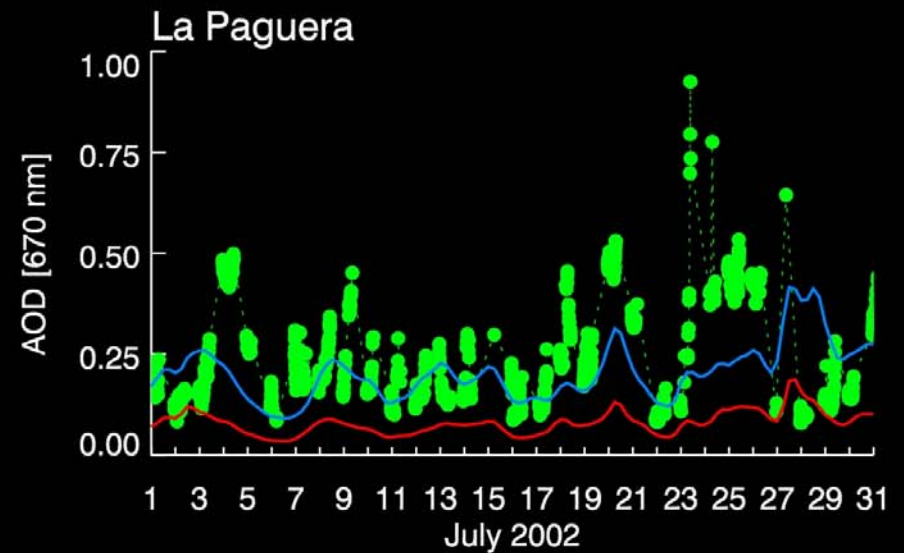
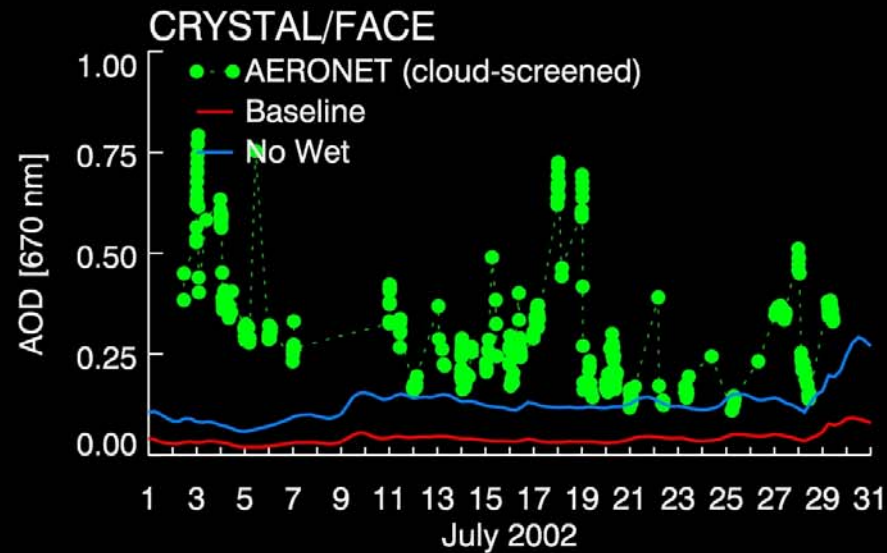
Dust Emissions [ $10^{-4}$  g cm $^{-2}$ ]



# AOD near Sources

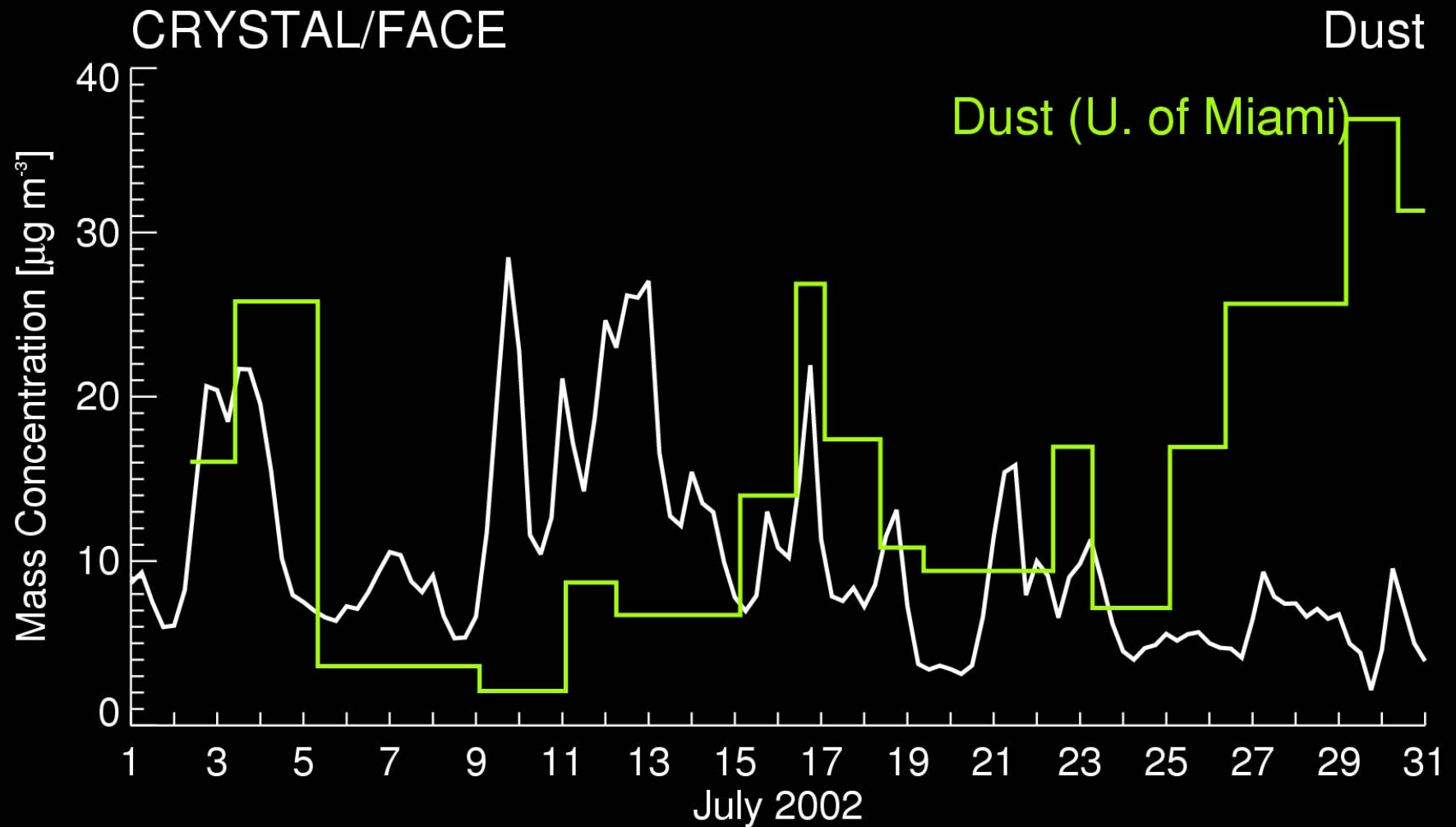


# AOD far from Sources





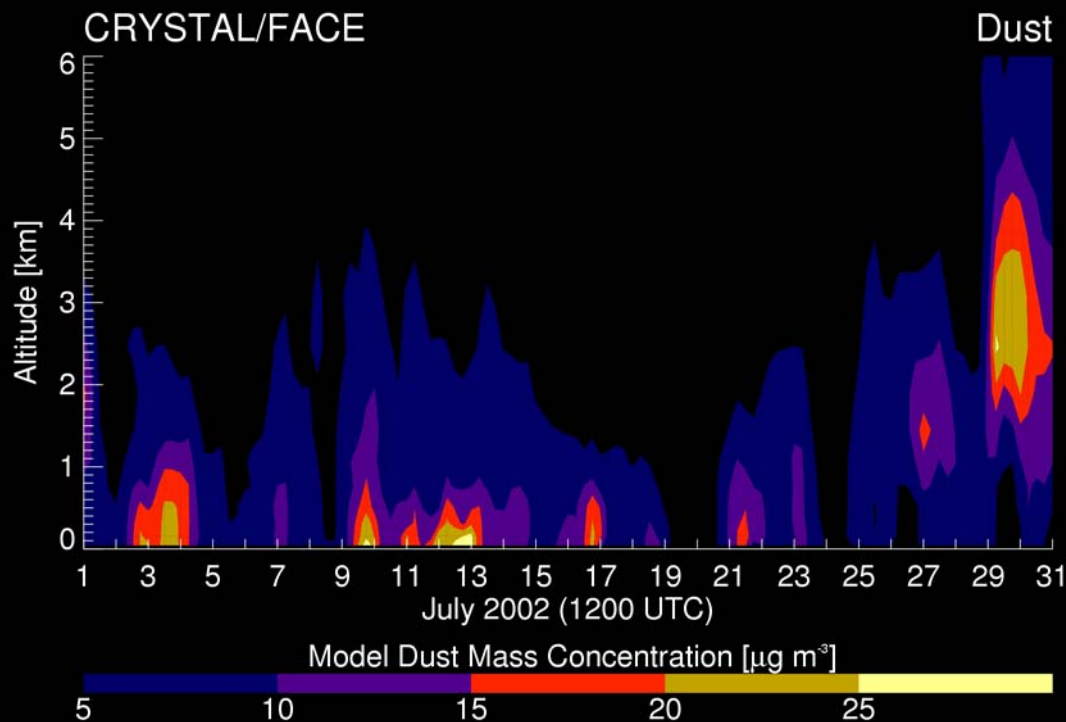
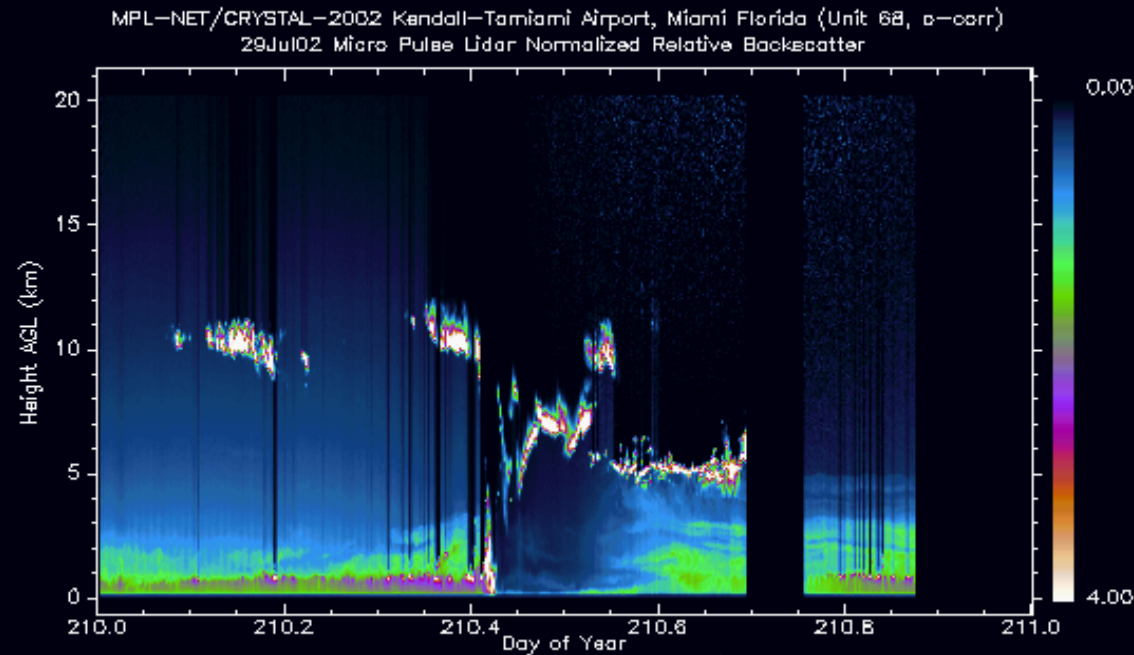
# Surface dust masses



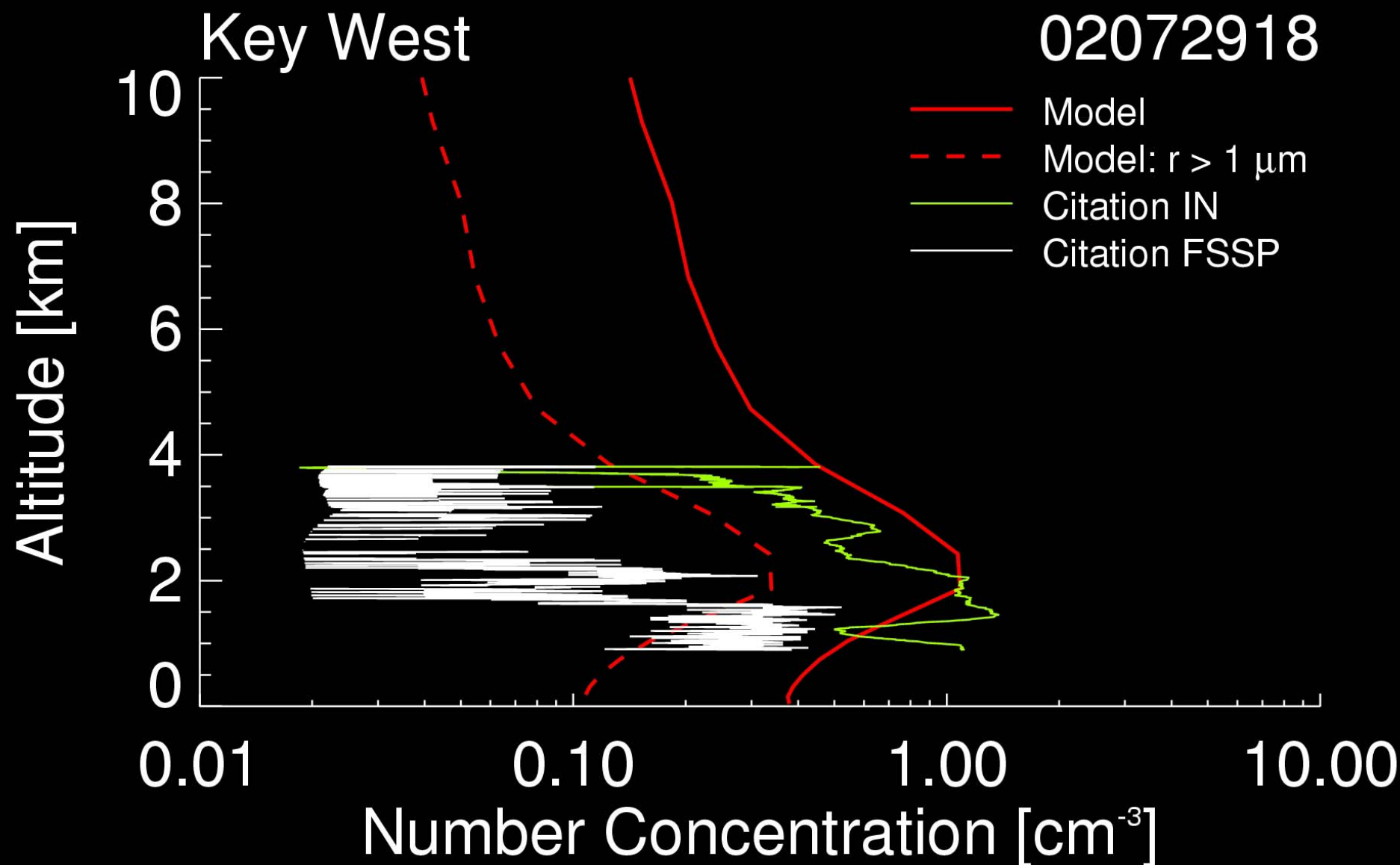
Model Dust Surface Mass Concentration [ $\mu\text{g m}^{-3}$ ]

# July 29, 2002

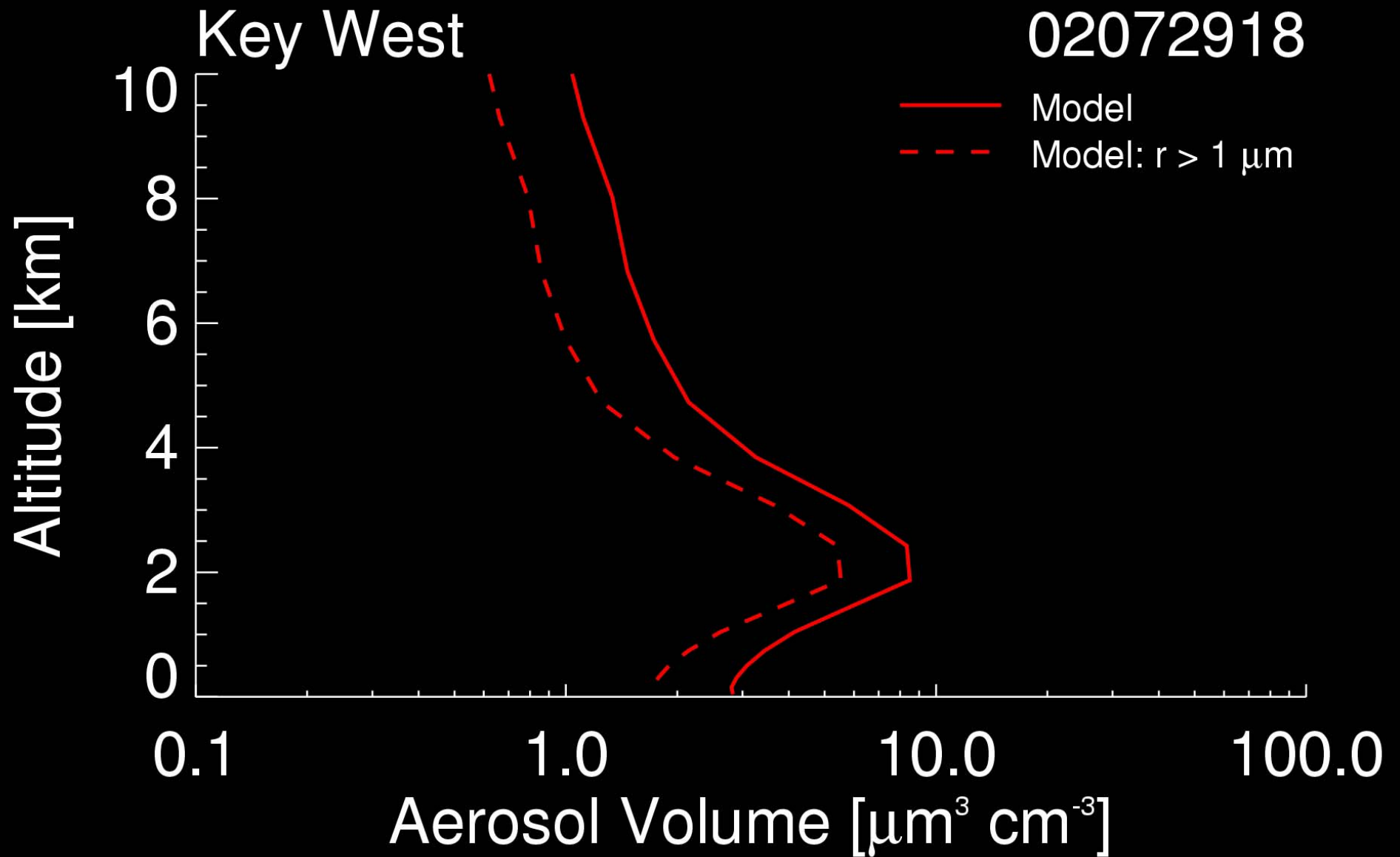
Both the model and the MPL see an elevated dust layer between 2 and 4 km



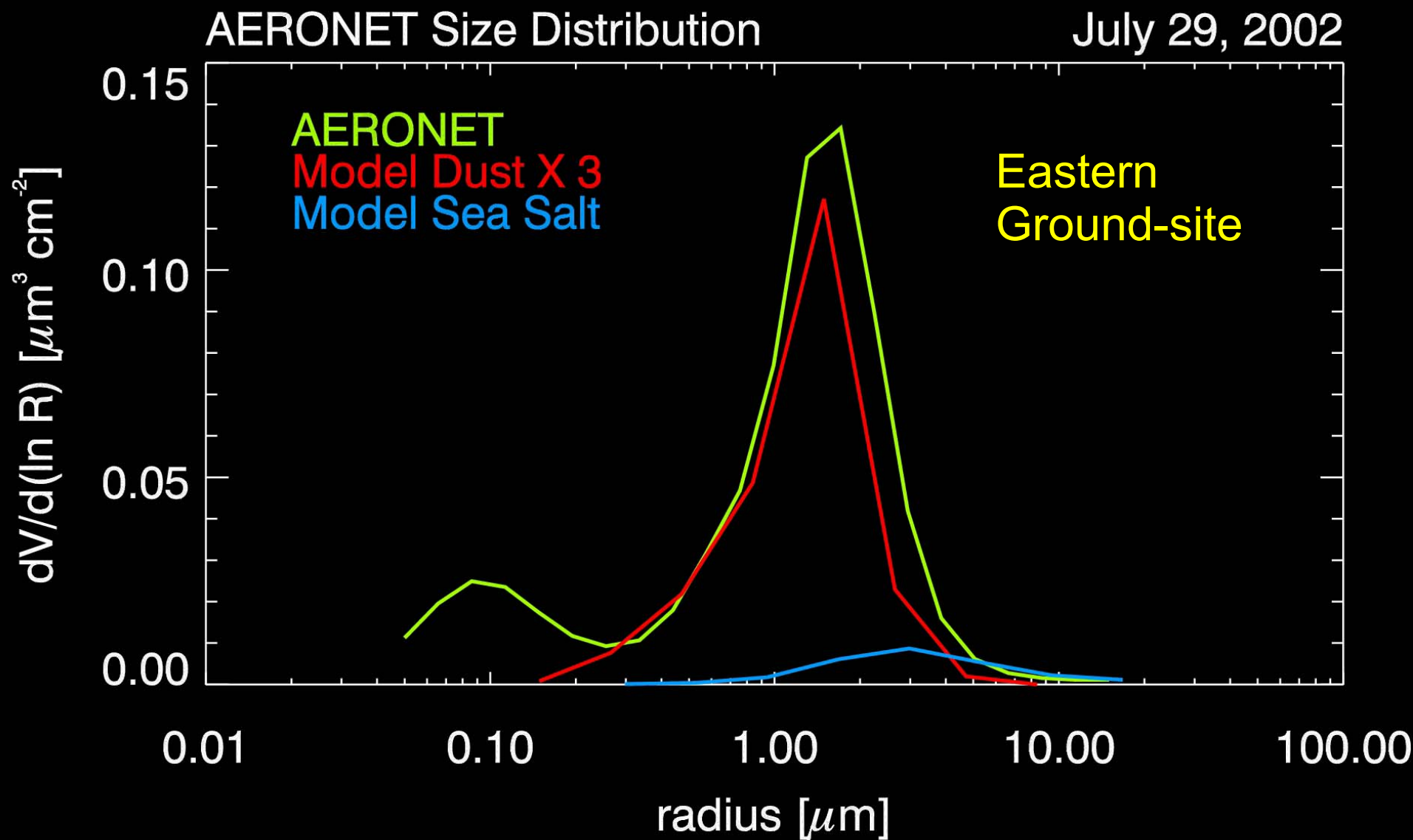
# Comparison to aircraft profile



# Volume profile

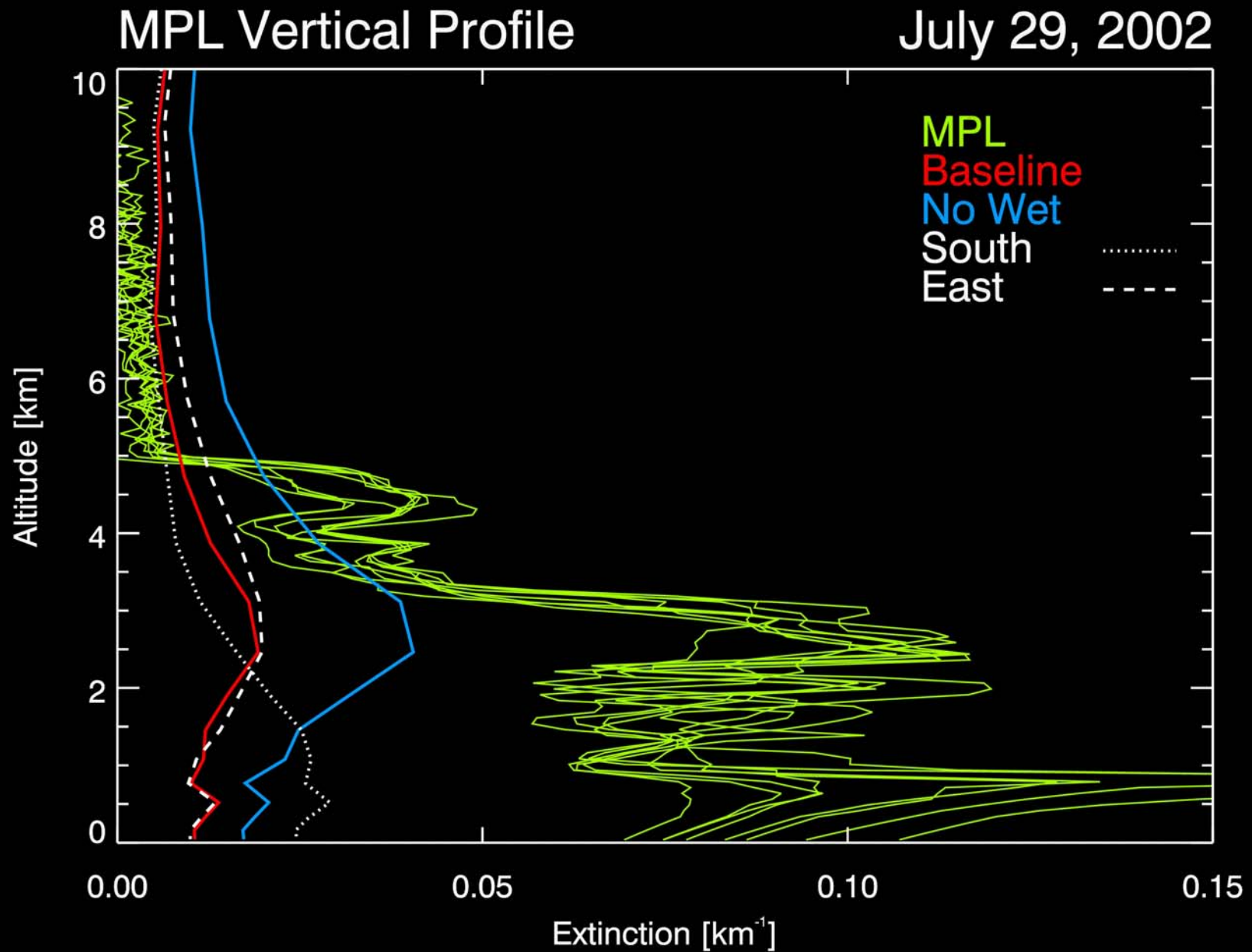


# Dust/Sea Salt Size Distribution

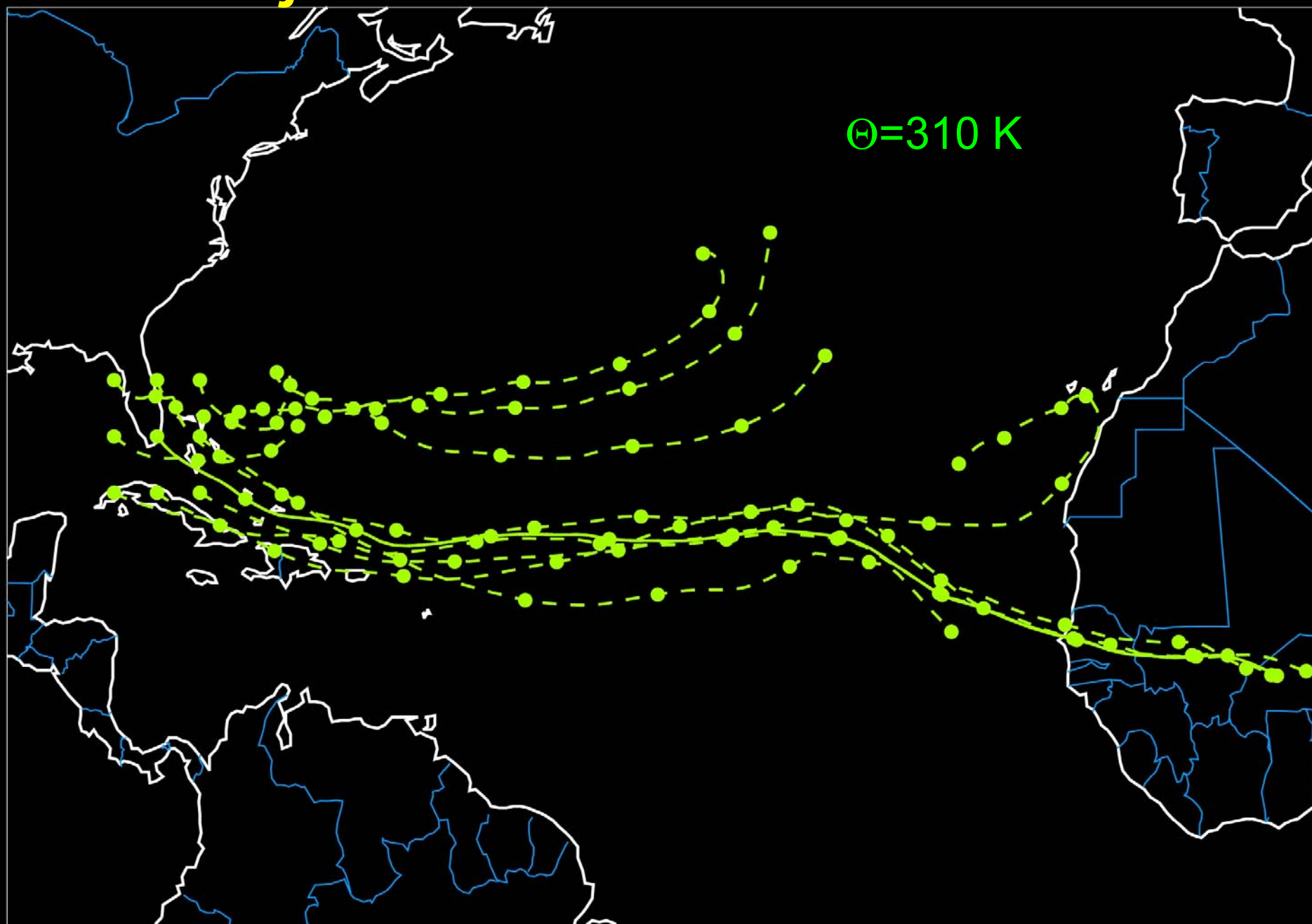




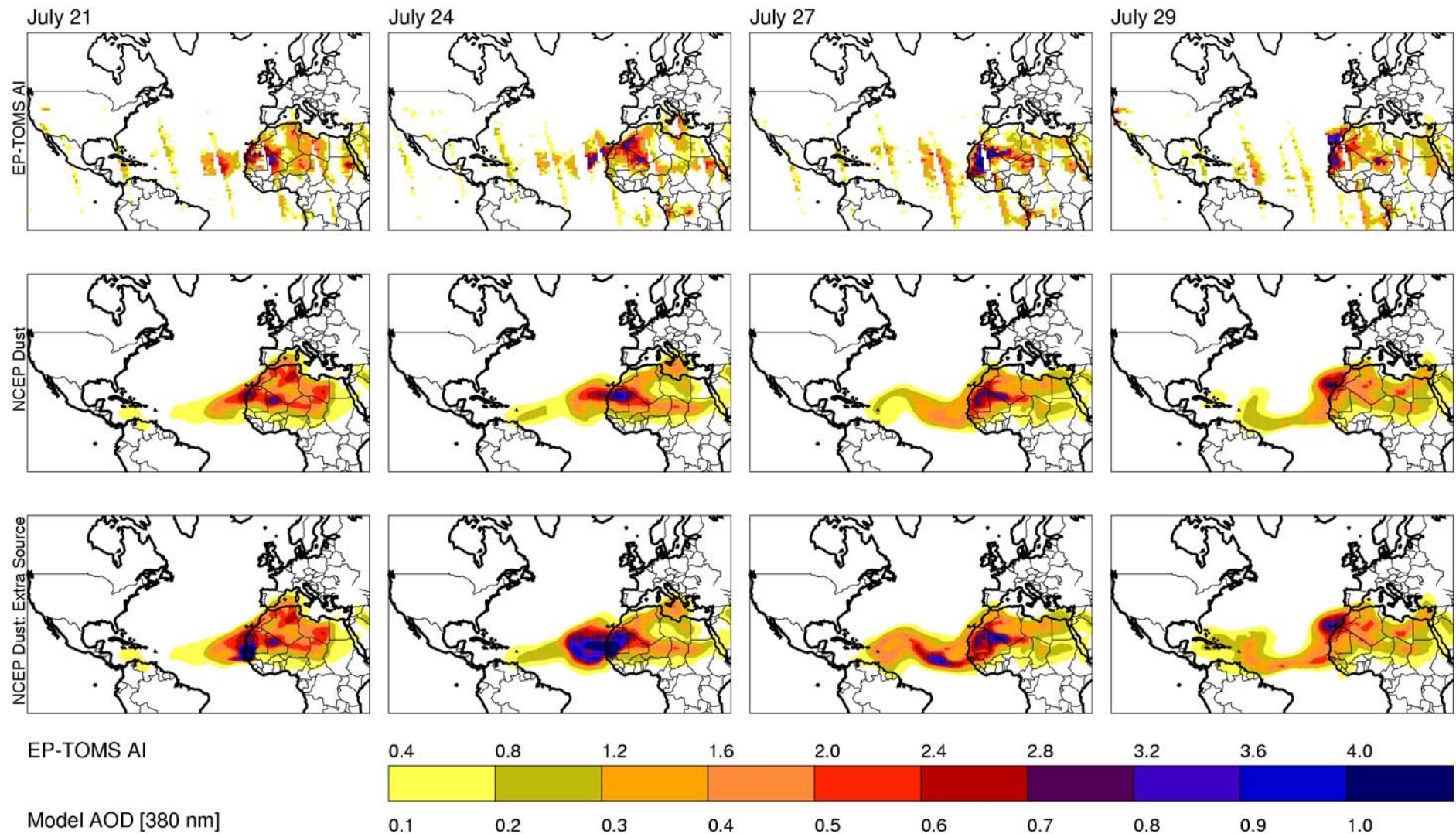
# Sensitivity Tests



# Back trajectories

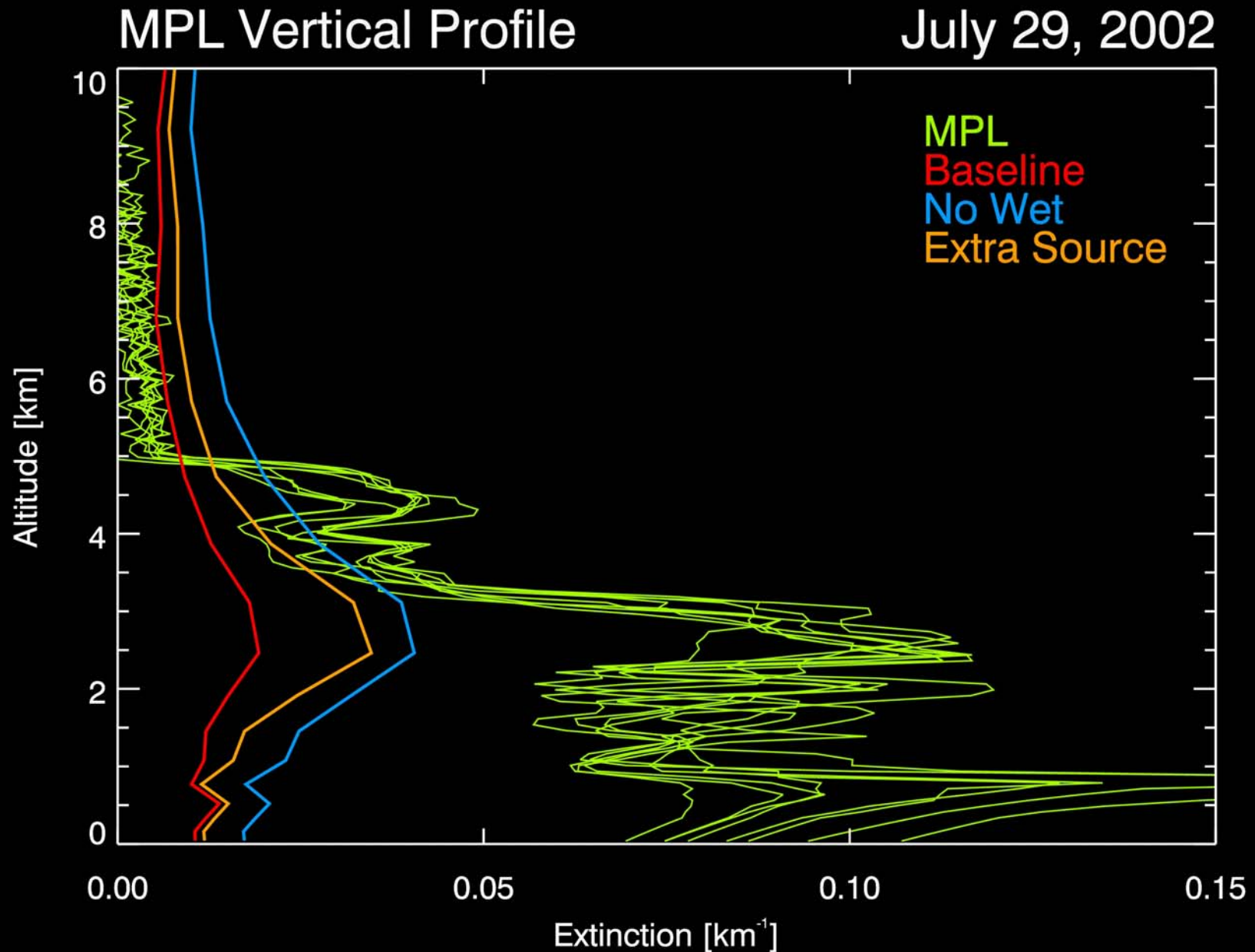


# Sensitivity Test: Add a Coastal Source





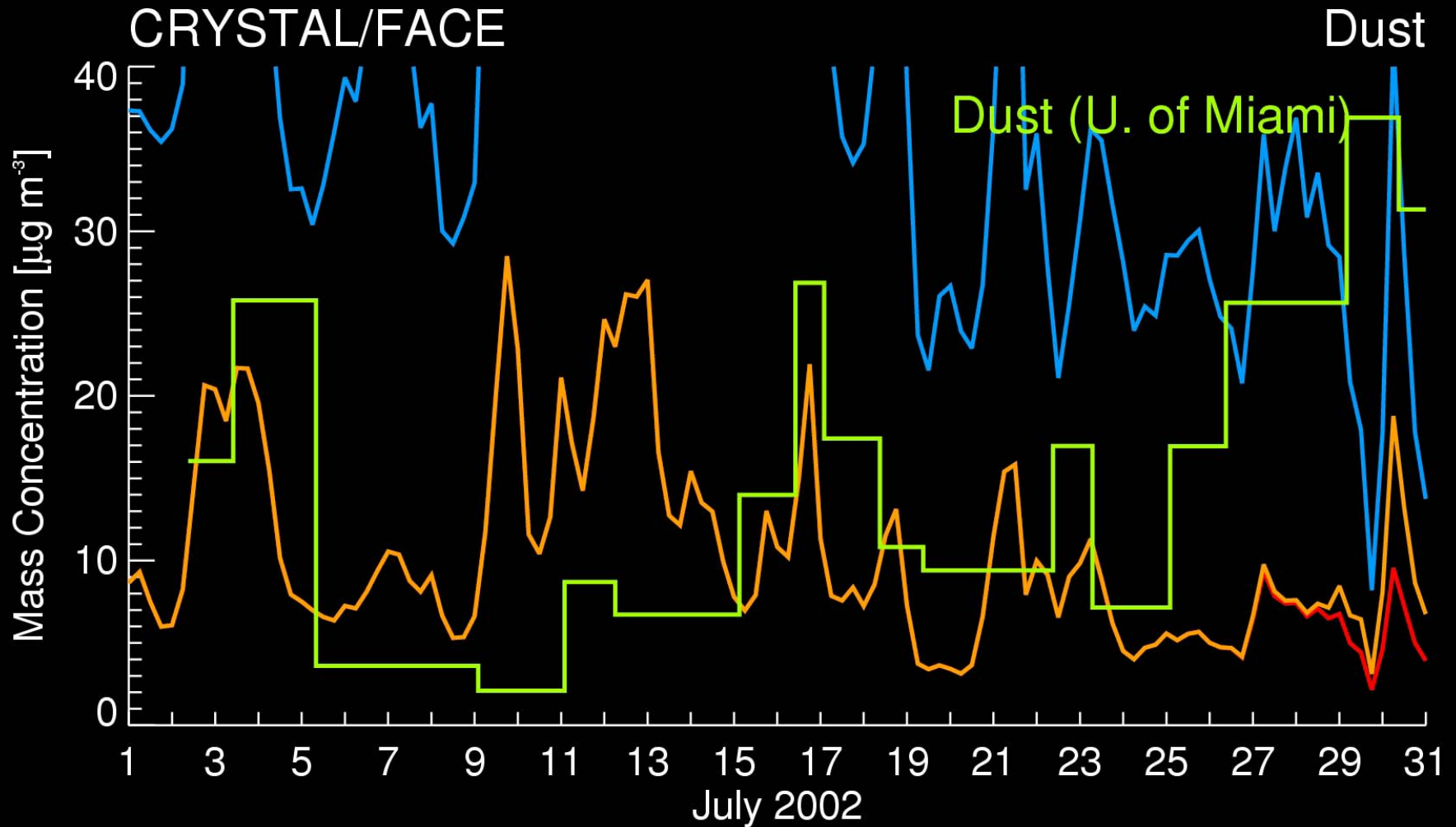
# Vertical Profile with Coastal Source



# Mass with Coastal Source

No wet simulations put too much dust at the surface

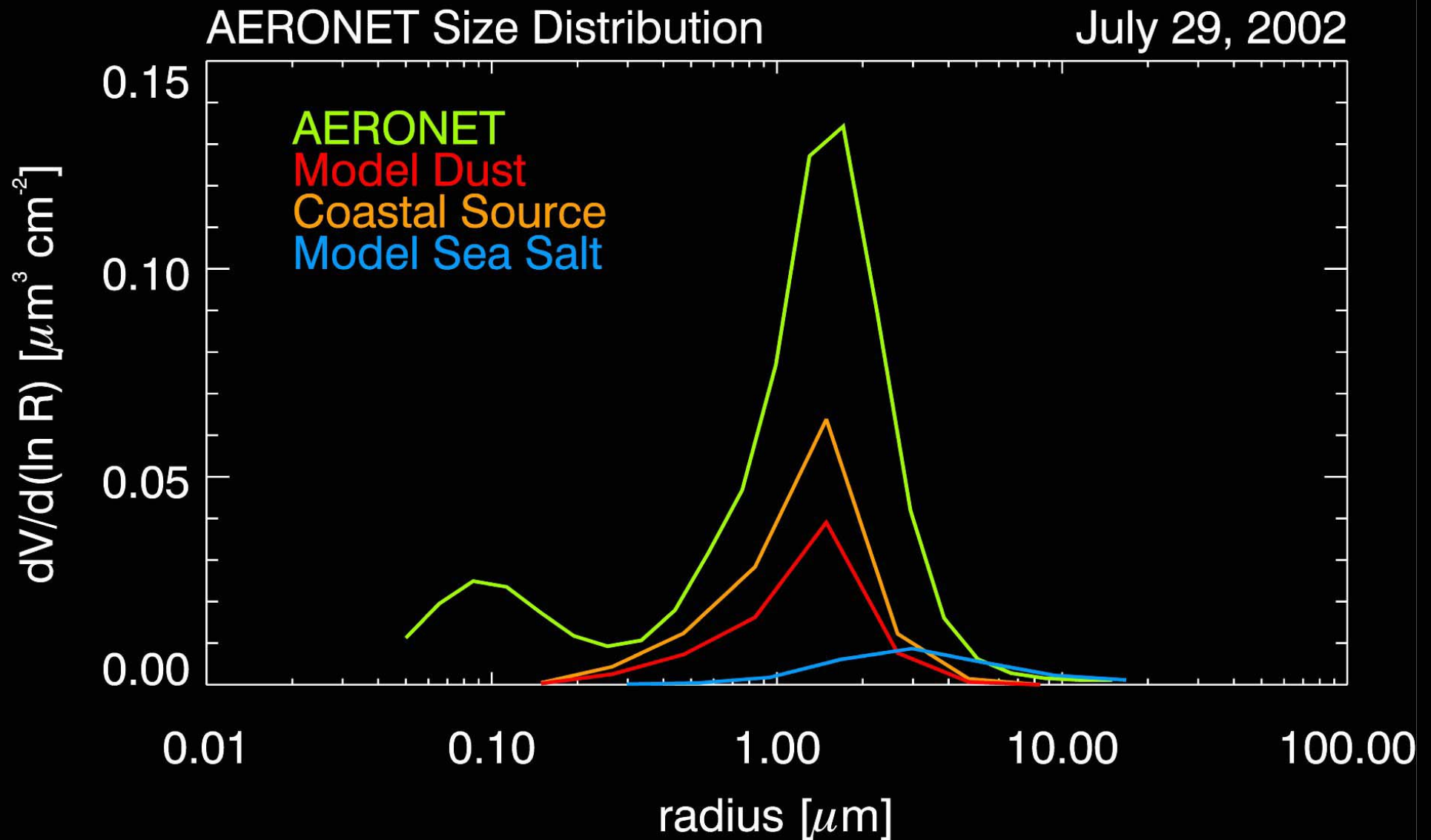
The added coastal source elevates the surface concentration



Model Dust Surface Mass Concentration [ $\mu\text{g m}^{-3}$ ]

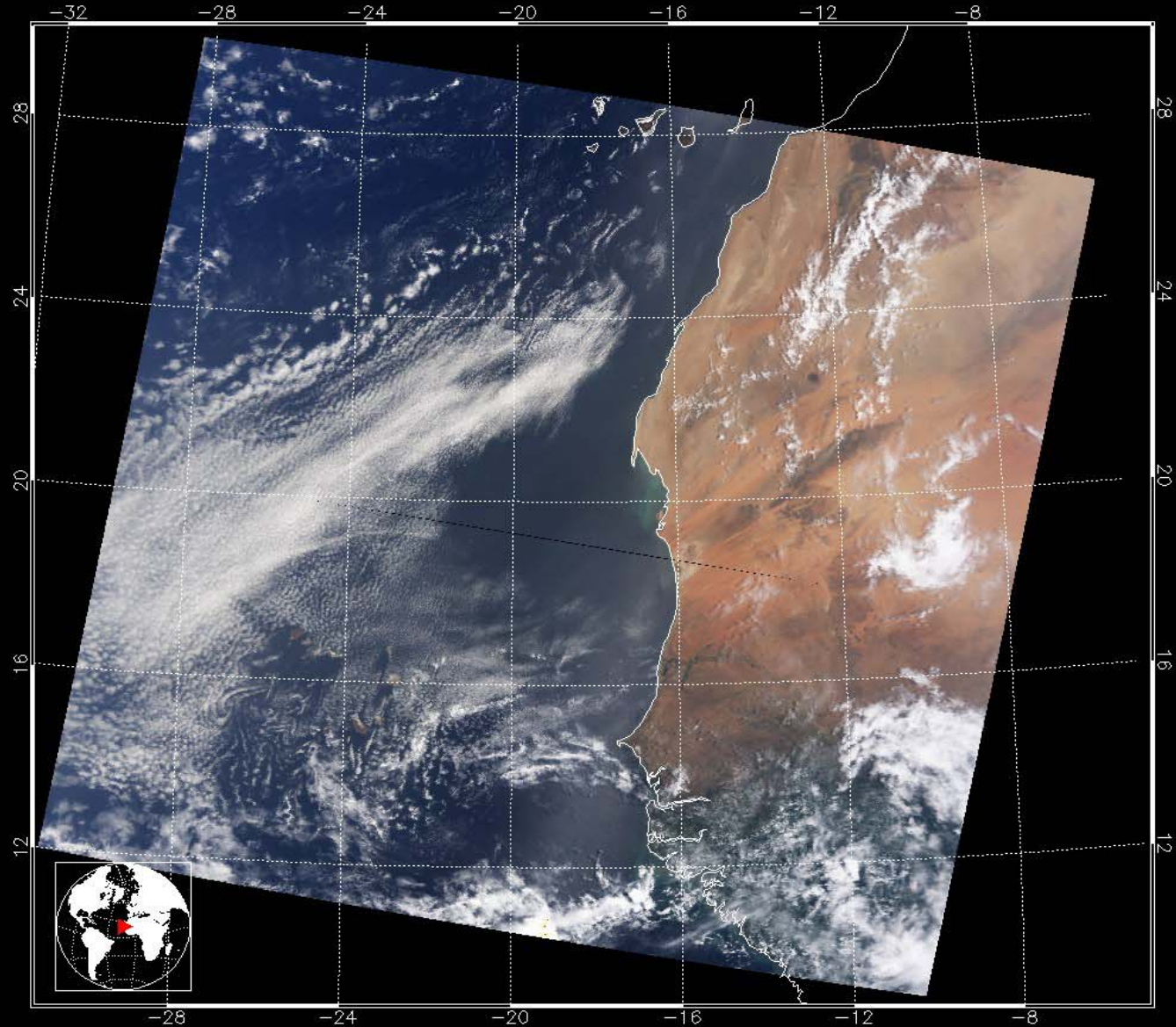


# Size Distribution with Coastal Source



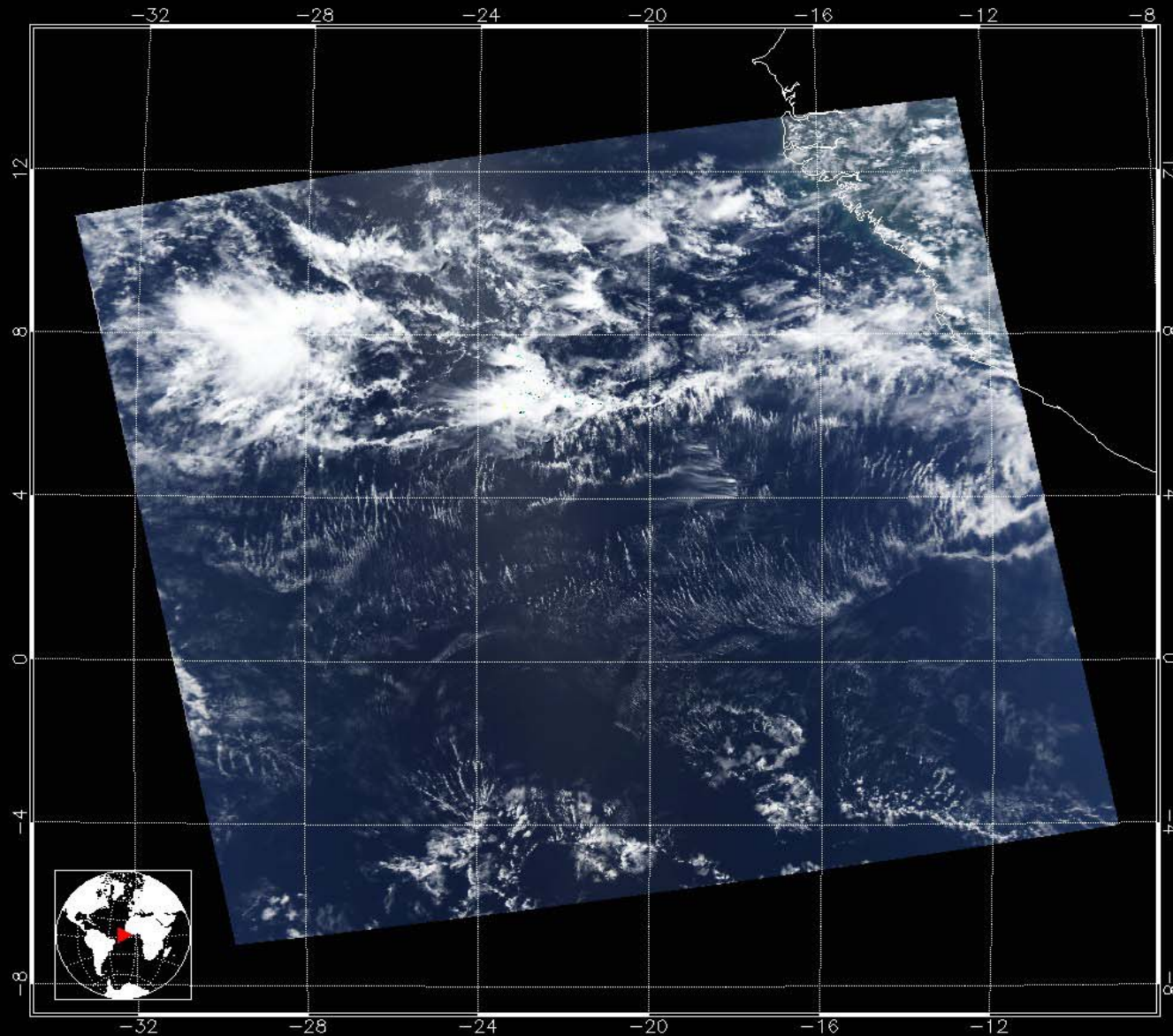
# Is this source in MODIS-Terra?

MOD021KM.A2002202.1155.003.2002202233649.hdf



# Is this source in MODIS-Aqua?

MYD021KM.A2002202.1455.003.2002205035054.hdf



# Conclusions

- Evidence for long-range transport of smoke over Florida
- The dust model shows dust at the right altitude on July 29
  - Not enough dust to match the lidar extinction
  - Surface concentrations are too low
- Turning off wet removal makes the rest of the simulation look worse
- Increasing the source or adding a coastal source can help, but what's the evidence for this?
- Possibly the wind fields are not right..?



# Future Directions

- Further evaluation of the sea salt source

- Include smoke aerosol in the simulation for the CF time frame

- Try another wind source for the dust

  - emissions

  - transport

- Further investigate the removal mechanisms at play here

- Acknowledgement: Thanks to Leslie Lait for some quick computer help!



